



# Range extension and first record of *Euryzygomatomys spinosus* (Rodentia, Echimyidae) in the Brazilian Cerrado

**Ana Carolina Loss<sup>1</sup>, Marco Aurélio C. Pacheco<sup>2</sup>, Yuri L. R. Leite<sup>1</sup>, Vilacio Caldara-Junior<sup>3</sup> and Leonardo G. Lessa<sup>2\*</sup>**

<sup>1</sup> Universidade Federal do Espírito Santo, Departamento de Ciências Biológicas, Avenida Fernando Ferrari 514, Goiabeiras, CEP 29075-910, Vitória, ES, Brazil

<sup>2</sup> Universidade Federal dos Vales do Jequitinhonha e Mucuri, Departamento de Ciências Biológicas, Rodovia MGT 369, 5000, CEP 39100-000, Diamantina, MG, Brazil

<sup>3</sup> Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo, campus Santa Teresa, Rodovia ES 080, km 93, São João de Petrópolis, CEP 29660-000, Santa Teresa, ES, Brazil

\* Corresponding author. E-mail: [leoglessa@gmail.com](mailto:leoglessa@gmail.com)

**Abstract:** We present herein the first record of *Euryzygomatomys spinosus* (G. Fischer, 1814) in the Brazilian Cerrado, based on two adult male specimens collected in a “campo limpo” (dry grassland) area at Sempre Vivas National Park, state of Minas Gerais, southeastern Brazil, in June and August 2014. This taxon was previously known only from the Brazilian Pampas, Paraguayan Chaco Humedo and Atlantic Forest of southeastern and southern Brazil, northeastern Argentina and southern Paraguay. Our records increased the species geographic range 250 km northward, into the Cerrado ecoregion.

**Key words:** campo limpo, geographical range, Mammalia, savanna

## INTRODUCTION

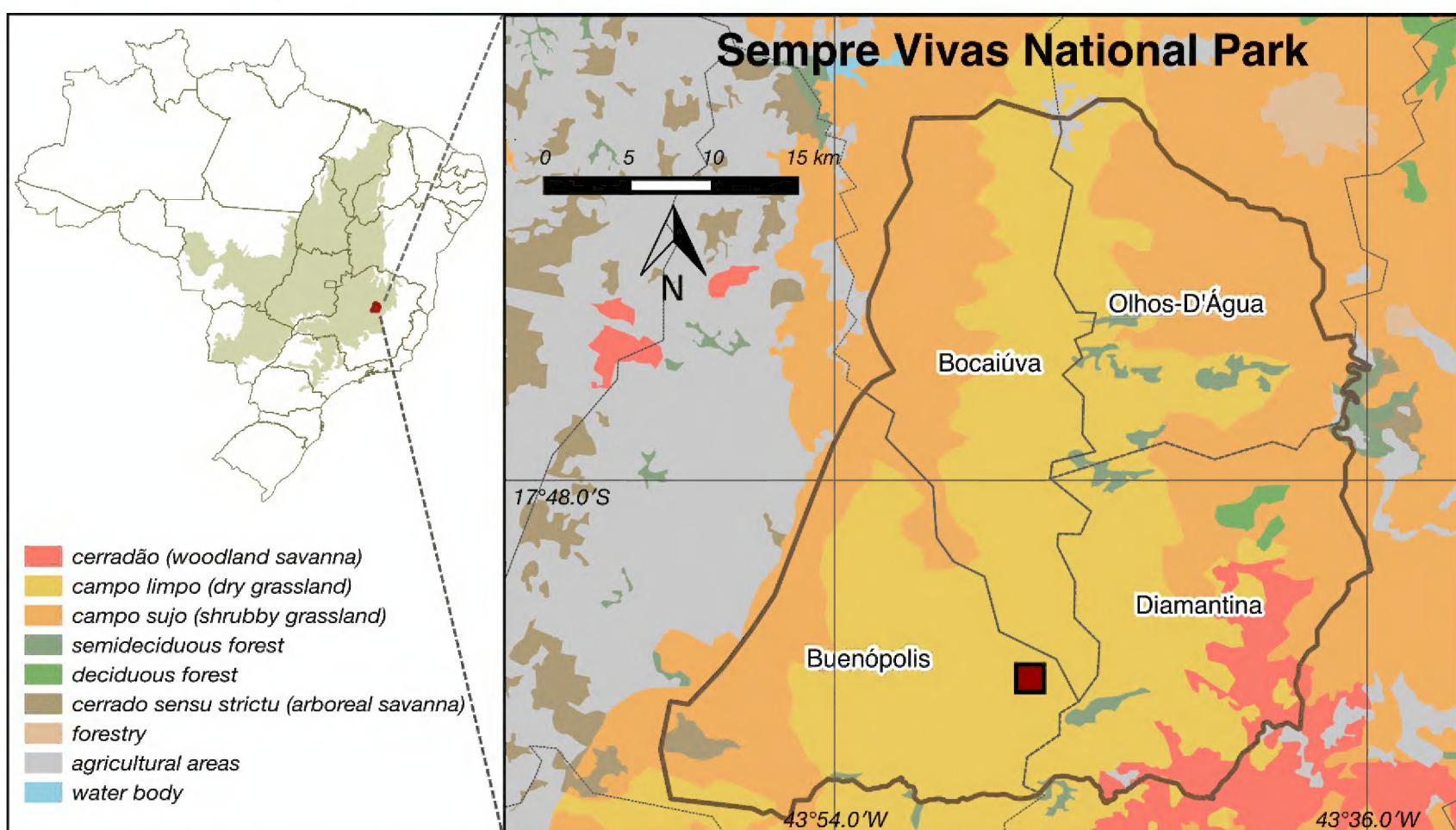
Spiny rats from the family Echimyidae are represented by 19 genera and around 90 recognized species (Fabre et al. 2013) distributed throughout the Neotropics (Emmons and Feer 1997). They are the most diverse group of hystricognath rodents (Leite and Patton 2002) and display a wide range of life histories and ecomorphological adaptations, ranging from semifossorial to arboreal life styles (Emmons and Feer 1997). In Brazil, semifossorial echimyid genera are found mainly in grasslands of the Cerrado and Pantanal (*Carterodon* and *Clyomys*) or in the Atlantic Forest ecoregion (*Euryzygomatomys*) (Paglia et al. 2012; Fabre et al. 2013). *Euryzygomatomys spinosus* (G. Fischer, 1814) is a medium sized, semifossorial rodent and the only living species currently recognized in its genus (Bonvicino and Bezerra 2015). It is characterized by a fusiform

body covered with brown to black spiny dorsal pelage, and short ears and tail (Eisenberg and Redford 1999; Bonvicino et al. 2008), typical of subterranean rodents. The dentition of *E. spinosus* is unique, characterized by very deep reentrant flexi/flexids, forming elongate fossettes/fossettids, and by the anterior fossette and metafossette subequal in size (Verzi et al. 1995). The karyotype of *E. spinosus* shows a diploid number (2n) of 46 and fundamental number (FN) of 82 chromosomes (Yonenaga 1975).

This taxon is rare in small mammal surveys (Bonvicino et al. 2002; Scheibler and Christoff 2007; Pinto et al. 2009), leading to relatively few localities with voucher specimens, and therefore resulting in imprecise range boundaries and many distribution gaps. In the present paper, we review published and museum records of *E. spinosus* and present a distribution map with georeferenced collecting points. We also report the first confirmed occurrence of *E. spinosus* in the Brazilian Cerrado.

## MATERIAL AND METHODS

We trapped two specimens of *E. spinosus* at Sempre Vivas National Park (17°54'50.48" S, 043°47'32.60" W, elevation 1,270 m), in northern Minas Gerais state, southeastern Brazil, during two field trips in June and August, 2014. This park covers an area of approximately 124,000 ha (Brasil 2002) of a mosaic vegetation of Cerrado physiognomies, including “campo limpo” (dry grasslands), “campo sujo” (shrubby grassland) and “cerradão” (woodland savanna) as well as pockets of semideciduous and deciduous forests (Figure 1) (Sano et al. 2007). The average temperature is 20°C, average annual rainfall ranges from 1,250–1,500 mm, and



**Figure 1.** Map showing Sempre Vivas National Park and its vegetation, based on Embrapa Cerrados (2006) and Sano et al. (2007). Red square inside Park area represents collecting locality of the two specimens of *Euryzygomatomys spinosus*. Names are from municipalities and shaded area in the Brazil inset map corresponds to the Cerrado range.

altitude varies from 650–1,520 m (Leal et al. 2008). All specimens were collected in a “campo limpo” area, which is part of a mosaic that includes upland mesophytic semideciduous forests (Figures 1 and 2).

The specimens were trapped in Tomahawk traps (300 × 160 × 160 mm) set on the ground and baited with a mixture of banana, sardine oil, corn meal and oat grains. Two voucher specimens (both adult males) were preserved as study skin, skull, post-cranial skeleton, and tissue samples (liver fixed in 96% ethanol), and have been deposited in the small mammal collection at Departamento de Ciências Biológicas, Universidade Federal dos Vales do Jequitinhonha e Mucuri, Diamantina, Minas Gerais, Brazil, under the catalog numbers MDIA078 and MDIA086. Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) issued the collecting permit (number 42892-1).

The first 801 base pairs of the mitochondrial cytochrome b gene (cyt b) were sequenced in order to

confirm the taxonomic identification, because this molecular marker is an effective tool in species level identification of mammals (Bradley and Baker 2001). Nucleic acids were isolated following Bruford et al. (1992), and the cyt b was amplified by polymerase chain reaction with primers MVZ05 and MVZ16 (Smith and Patton 1993). For a final volume of 25 µl, we added 2.5 µl of buffer (10×), 1.0 µl of MgCl<sub>2</sub> (50 mM), 0.5 µl of deoxynucleoside triphosphate mix (10 mM for each nucleotide), 0.3 ml of each primer (10 mM each), 3 units of Taq Platinum (Invitrogen Corporation, Carlsbad, California), and 1 ml of DNA template. The polymerase chain reaction profiles included an initial denaturation at 94°C for 5 min, followed by 39 cycles and a final extension at 72°C for 7 min. Cycles began with a denaturation at 94°C for 30 s, annealing at 48°C for 45 s, and extension at 72°C for 45 s. The sample was sequenced in both directions with the same primers listed above. The cyt b sequence was aligned using Geneious 5.6 (Biomatters, Auckland, New Zealand), deposited in GenBank (<http://www.ncbi.nlm.nih.gov/genbank>) under the accession number KM514670, and compared with other sequences from GenBank (accession numbers EU544667, JF297804, U34858) using pairwise p-distance calculated in Geneious.

In order to map the range of *E. spinosus*, we used records from published papers and museum vouchers. *Euryzygomatomys spinosus* is the only semifossorial Echimyidae occupying the Atlantic Forest and can be easily identified by its external morphology, so we considered published records within Atlantic Forest domain as correct. Nonetheless, *Clyomys* or *Carterodon*



**Figure 2.** Campo limpo area and upland mesophytic semideciduous forest habitat in Sempre Vivas National Park, northern Minas Gerais, Brazil, where two *Euryzygomatomys spinosus* specimens (MDIA078 and MDIA086) were collected. Photo by Pacheco MAC.

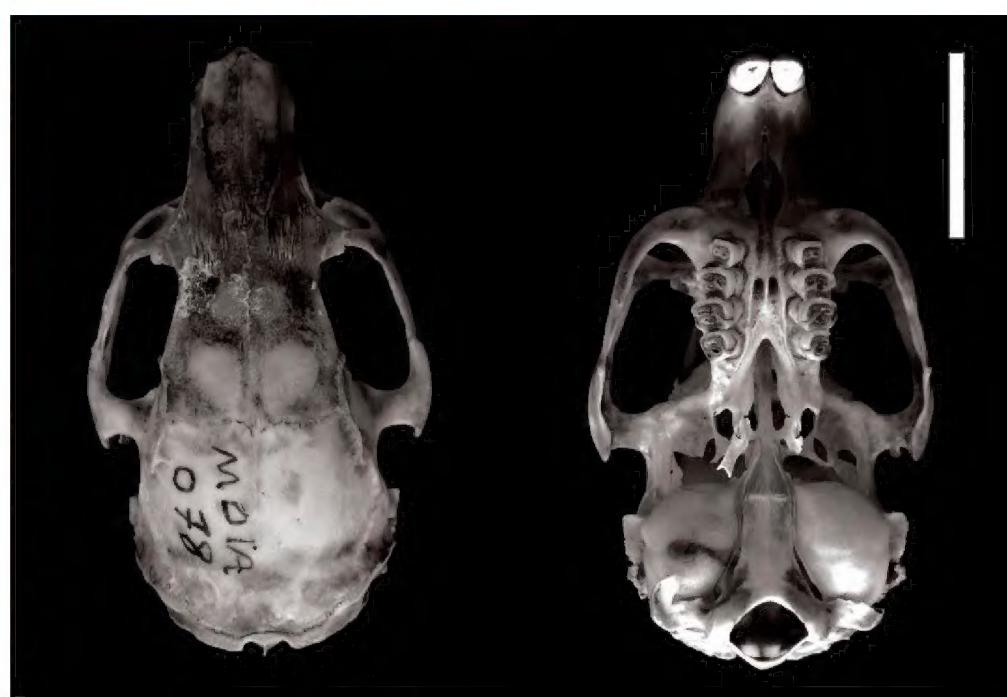


**Figure 3.** Adult male (age class 6) of *Euryzygomatomys spinosus* (MDIA078) from Sempre Vivas National Park, northern Minas Gerais, Brazil. Photo by Pacheco MAC.

may be misidentified as *Euryzygomatomys* in transitional areas between Cerrado and Atlantic Forest, especially in the states of Minas Gerais and São Paulo. For records within this area, we only considered records valid after analyzing museum vouchers. Uncertain records were not included on the map.

We examined external and dental morphology of the two voucher specimens of *E. spinosus* (Figures 3 and 4) and confirmed the taxonomic identification by sequencing the cyt b from one specimen (MDIA078). The sequence from the specimen collected at Sempre Vivas National Park (Figure 5, locality 1) is 1.1% divergent from that of a specimen collected at Biritiba Mirim (Figure 5, locality 16; Genbank EU544667), state of São Paulo, and 0.6% divergent from that of another specimen collected at Sumidouro (Figure 5, locality 11; Genbank U34858), state of Rio de Janeiro. These low genetic divergence values are congruent with the expectations for intraspecific variation within mammal species (Bradley and Baker 2001), and therefore endorse the identification of this specimen as *E. spinosus*. We took 25 craniodental measurements with a digital caliper and determine age category based on upper cheekteeth worn, following Bezerra and Oliveira (2010) (Table 1).

The literature suggests that *E. spinosus* occurs mainly in the Atlantic Forest (Bonvicino et al. 1997; Pinto et al. 2009; Bonvicino and Bezerra 2015) and it is found in the southern portions of this ecoregion (Moojen 1952; Bonvicino et al. 2008) in Paraguay, northeastern Argentina (Eisenberg and Redford 1999; Chu et al. 2003; Cirignoli et al. 2011), and from sea level to high-altitude areas in southeastern and southern Brazil (Table 2; Bonvicino and Bezerra 2015). Indeed, the range of *E. spinosus* nearly matches the geographic distribution of the Atlantic Forest to the south of the Rio Doce (see maps in Bonvicino et al. 2008; Catzeffis et al. 2008; Bonvicino and Bezerra 2015). The type locality of the

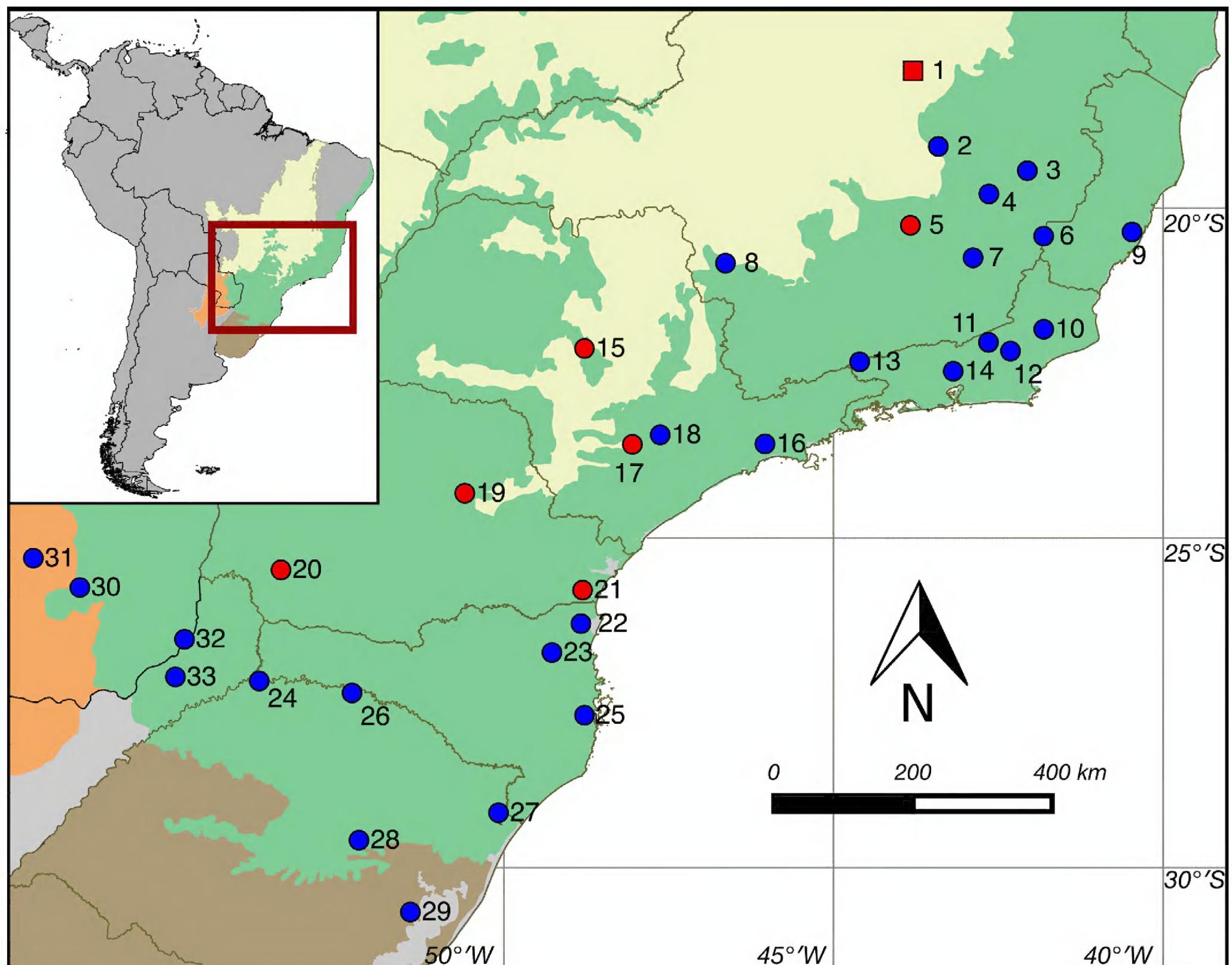


**Figure 4.** Dorsal and ventral views of the skull of *Euryzygomatomys spinosus* (MDIA 078) collected at Sempre Vivas National Park, Minas Gerais, Brazil. Photo by Pacheco MAC. Scale bar = 20 mm.

**Table 1.** Selected measurements (in mm) of the two specimens of *Euryzygomatomys spinosus* from Sempre Vivas National Park, Minas Gerais, Brazil.

	MDIA078	MDIA084
Age category	6	5
Cranial depth at the tympanic bulla (CD)	16.47	17.08
Greatest length of skull (GLS)	51.39	50.80
Rostral depth (RD)	10.26	10.04
Nasal length (NL)	15.42	15.06
Rostral length (RL)	18.35	18.65
Rostral breadth (RB)	6.20	6.34
Interorbital constriction (IO)	11.01	12.72
Cranial breadth immediately posterior to the zygomatic arches (CRB)	17.48	19.12
Cranial breadth at the external auditory meatus (CMB)	23.37	25.91
Greatest zygomatic arch breadth (ZB)	28.92	30.09
Condylarbasal length (CB)	48.65	48.23
Palatal length (PLL)	23.63	22.67
Palatilar length (PLT)	21.31	20.29
Diastema length (D)	13.18	12.83
Incisive foramina length (IFL)	6.98	6.00
Incisive foramina breadth (IFB)	2.95	2.97
Upper molar row length (UML)	14.78	14.92
Palatal breadth (MX)	11.55	11.08
Mesopterygoid fossa breadth (MPF)	4.03	4.03
Postpalatal length (PPL)	24.73	24.89
Greatest breadth of the tympanic bulla (BB)	9.48	10.56
Greatest length of the tympanic bulla (BL)	11.57	13.11
Mandibular ramus length (MRL)	15.29	15.32
Mandible length (ML)	29.65	29.01
Length of lower molar row (LML)	11.55	10.75

species is Atyra, southern Paraguay (Bonvicino and Bezerra 2015), within the Chaco Humedo ecoregion (Olson et al. 2001). Although Paglia et al. (2012) reported *E. spinosus* in the Atlantic Forest, Pampas and Cerrado, no specimen has ever been recorded in a typical Cerrado habitat, but in transitional areas between Cerrado and Atlantic Forest (Figure 5; localities 2, 8, 17 and 19). Some authors recently indicated the occurrence of *E. spinosus*



**Figure 5.** Collecting localities of *Euryzygomomys spinosus* in Brazil, Paraguay and Argentina. Blue dots represent published records; red dots show new records based on specimens examined from museum collections and published data; red square (locality 1) shows our new record from Sempre Vivas National Park, in the Brazilian Cerrado. Numbers correspond to localities listed in Table 2. Green area corresponds to the Atlantic Forest, yellow area to the Cerrado, brown area to the Pampas and orange area to the Chaco Humedo. Map based on Olson et al. (2001) and IBGE (2004).

in Cerrado areas of central Brazil (Lacher and Alho 2001; Santos-Filho et al. 2012), but these were based on misidentified specimens of the genus *Carterodon*. The specimens from Usina Hidrelétrica Manso, Chapada dos Guimarães, Mato Grosso, Brazil, were reexamined and identified as *Carterodon sulcidens* (Lund, 1841), a morphologically similar echimyid rodent (Bezerra et al. 2011). Bonvicino and Bezerra (2015) mentioned tree specimens from Serra das Araras Ecological Station, Porto Estrela, Mato Grosso (Santos-Filho et al. 2012) as “misidentified as *Carterodon sulcidens*”, but they were misidentified as *Euryzygomomys spinosus* and were confirmed to represent specimens of *C. sulcidens* (M. Santos-Filho, personal comm.; Bonvicino and Bezerra, 2015 distributional map). Therefore, the present paper documents the first confirmed record of *E. spinosus* in the Cerrado ecoregion, extending its geographic range 250 km northward.

The paucity of reliable geographic information on

*E. spinosus* also reflects how little is known about the biology of this species, including behavior and ecology. For example, information on feeding habits is still very scarce. Gonçalves et al. (2007) observed the consumption of *Pinus taeda* (Pinaceae) in southern Brazil and Paglia et al. (2012) and Bonvicino and Bezerra (2015) classified *E. spinosus* as herbivore, while Stallings (1989) considered it as most probably herbivore-grazer. One of us (YLRL) observed *E. spinosus* consuming leaves of the invasive exotic grass *Melinis minutiflora* P. Beauv., which dominated the grassland habitat where these rodents lived at Poço das Antas Biological Reserve, state of Rio de Janeiro. The fecal analysis of the specimens collected in this study indicates the consumption of vegetative parts of plants (leaves and steams), but also insects (Coleoptera, Hymenoptera, and Hemiptera). These findings suggest an omnivorous diet in *E. spinosus*, but this is based on only two adult males.

*Euryzygomomys spinosus* occupies different

habitats and can be considered a habitat generalist (Mares and Ojeda 1982; Bonvicino and Bezerra 2015). This species occurs in *Pinus* plantations (Gonçalves et al. 2007), montane forests (Bonvicino et al. 1997; Geise et al. 2004), secondary vegetation (Lessa et al.

1999; Scheibler and Christoff 2007), dry grasslands (this study), wet meadows (Stallings 1989) and nearby agriculture fields (D'Andrea et al. 2007; Pinto et al. 2009), from sea level to high altitude areas (above 2,300 m; Table 2).

**Table 2.** Confirmed records of *Euryzygomomys spinosus* sorted according to numbered localities mapped in Figure 5, and corresponding reference and/or voucher number (when examined). References in bold indicate species identity confirmed also by DNA analysis and corresponding Genbank accession code for cyt b sequence in parenthesis.

Locality number	Specific locality	State/ Department/ Province	Country	Latitude South	Longitude West	Altitude (m)	Reference / Voucher*
1	Sempre Vivas National Park	Minas Gerais	Brazil	17.9140	043.7924	1,270	Present study / <b>MDIA 078 (KM514670)</b> , 086
2	Boca da Mata, Conceição do Mato Dentro	Minas Gerais	Brazil	19.0599	043.4100	866	Bonvicino and Bezerra (2015) / MN 13363, 13371, 13419, 1894
3	Caratinga	Minas Gerais	Brazil	19.4300	042.0666	612	Bonvicino and Bezerra (2015) / MN 24147, 24149, UFMG 986
4	Parque Estadual do Rio Doce	Minas Gerais	Brazil	19.6520	042.5594	297	Stallings (1989)
5	Itabirito	Minas Gerais	Brazil	20.2592	043.8333	941	<b>MCN-M 117</b>
6	Terreirão, Alto Caparaó	Minas Gerais	Brazil	20.4225	041.8125	2,363	Bonvicino et al. (1997)
7	Mata do Paraíso, Viçosa	Minas Gerais	Brazil	20.7500	042.8833	664	Lessa et al. (1999) / UFV 2209
8	Passos	Minas Gerais	Brazil	20.8331	046.6383	912	Bonvicino and Bezerra (2015) / MN 31557
9	Coacas, Viana	Espírito Santo	Brazil	20.3592	040.4728	131	Pinto et al. (2009) / UFES 835
10	Parque Estadual do Desengano, Campos dos Goytacazes	Rio de Janeiro	Brazil	21.8340	041.8118	776	Modesto et al. (2008)
11	Sumidouro	Rio de Janeiro	Brazil	22.0333	042.6500	381	D'Andrea et al. (2007) / <b>MN 43755 (U34858)</b>
12	Nova Friburgo	Rio de Janeiro	Brazil	22.1655	042.3152	661	Bonvicino and Bezerra (2015)
13	Maromba, Itatiaia	Rio de Janeiro	Brazil	22.3280	044.6033	1,459	Geise et al. (2004) / MZUSP 8078
14	Duque de Caxias	Rio de Janeiro	Brazil	22.4708	043.1842	1,054	Bonvicino and Bezerra (2015) / MN 50721, 53885
15	Boracéia	São Paulo	Brazil	22.1257	048.7793	449	MZUSP 9803, 10036, 10755, 10821, 24875, 25876
16	Casa Grande, Biritiba Mirim	São Paulo	Brazil	23.5725	046.0386	768	Vilela et al. (2009) / <b>EU544667</b>
17	Itapetininga	São Paulo	Brazil	23.5800	048.0500	693	MN 24150, 31560
18	Floresta Nacional de Ipanema	São Paulo	Brazil	23.4353	047.6281	781	Bonvicino and Bezerra (2015)
19	Klabin, Telêmaco Borba	Paraná	Brazil	24.3207	050.5946	735	MHNCI 1267, 1268, 3758
20	Usina Hidrelétrica de Salto Caxias, Flor da Serra, Boa Vista da Aparecida	Paraná	Brazil	25.4838	053.3826	423	MHNCI 4496, 4643, 4834
21	Serra da Prata, Guaratuba	Paraná	Brazil	25.7903	048.8069	494	MHNCI 2422
22	Joinville	Santa Catarina	Brazil	26.3000	048.8333	9	Bonvicino and Bezerra (2015)
23	Rio dos Cedros	Santa Catarina	Brazil	26.7383	049.2742	110	Cherem et al. (2004) / UFSC 941
24	Itapiranga	Santa Catarina	Brazil	27.1694	053.7122	242	Cherem et al. (2004) / UFSC 073
25	Parque Estadual da Serra do Tabuleiro, Santo Amaro da Imperatriz	Santa Catarina	Brazil	27.6881	048.7786	44	Cherem et al. (2011) / UFSC 2779
26	Usina Hidrelétrica de Itá, Aratiba	Rio Grande do Sul	Brazil	27.3502	052.3052	456	Leite et al. (2008)
27	Cambará do Sul	Rio Grande do Sul	Brazil	29.1667	050.0833	741	Gonçalves et al. (2007)
28	Venâncio Aires	Rio Grande do Sul	Brazil	29.5333	052.2000	89	Scheibler and Christoff (2007)
29	Tapes	Rio Grande do Sul	Brazil	30.6228	051.4200	11	Bonvicino and Bezerra (2015) / FZB-MCN 2364
30	Villarica	Guaira	Paraguay	25.7500	056.4333	147	Bonvicino and Bezerra (2015) / AMNH 66785
31	Atyrá	Cordillera	Paraguay	22.1500	057.1000	194	Bonvicino and Bezerra (2015)
32	Ape Aimé	Itapúa	Paraguay	26.5369	054.8456	176	Chu et al. (2003) / TK 66002
33	Reserva Valle del Cuña Pirú	Misiones	Argentina	27.1072	054.9839	214	Cirignoli et al. (2011) / CNP 791

\* MDIA = Universidade Federal dos Vales do Jequitinhonha e Mucuri, Diamantina, Brazil; MN = Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; MCN-M = Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Brazil; UFMG = Universidade Federal de Minas Gerais, Belo Horizonte, Brazil; UFV = Universidade Federal de Viçosa, Viçosa, Brazil; UFES = Universidade Federal do Espírito Santo, Vitória, Brazil; MZUSP = Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil; MHNCI = Museu de História Natural Capão da Imbuia, Curitiba, Brazil; UFSC = Universidade Federal de Santa Catariana, Florianópolis, Brazil; FZB-MCN = Museu de Ciências Naturais, Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre, Brazil; TK = The Museum, Texas Tech University, Lubbock, USA; CNP = Centro Nacional Patagónico, Puerto Madryn, Argentina.

## ACKNOWLEDGEMENTS

We thank Kamila Freitas and Sara Angelica Santos for fieldwork assistance. Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), regional bureau of Diamantina, Daniel Rios and Jerônimo Martins for their logistical support at Sempre Vivas National Park. Molecular laboratory work was conducted with grant support from Fundação de Amparo à Pesquisa e Inovação do Estado do Espírito Santo (FAPES, grant # 52274322) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, grant # 305008/2013-7) to YLRL. ACL had a predoctoral scholarship from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES; Programa de Demanda Social) and has a postdoctoral scholarship from FAPES (grant # 68854315/14).

## LITERATURE CITED

- Berreza, A.M.R. and J.A. Oliveira. 2010. Taxonomic implications of cranial morphometric variation in the genus *Clyomys* Thomas, 1916 (Rodentia: Echimyidae). *Journal of Mammalogy* 91(1): 260–272. doi: [10.1644/08-MAMM-A-320R1.1](https://doi.org/10.1644/08-MAMM-A-320R1.1)
- Bezerra, A.M.R., J. Marinho-Filho and A.P. Carmignotto. 2011. A review of the distribution, morphometrics, and habit of Owl's Spiny Rat *Carterodon sulcidens* (Lund, 1841) (Rodentia: Echimyidae). *Zoological Studies* 50: 566–576. <http://zoolstud.sinica.edu.tw/Journals/50.5/566.pdf>
- Bonvicino, C.R. and A.M.R. Bezerra. 2015. Genus *Euryzygomatomys* Goeldi, 1901; pp. 937–940, in: J.L. Patton, U.F.J. Pardiñas and G. D'Elia (eds.). *Mammals of South America, volume 2: rodents*, 1 ed. Chicago: University of Chicago Press.
- Bonvicino, C.R., A. Langguth, S.M. Lindbergh and A.C. de Paula. 1997. An elevational gradient study of small mammals at Caparaó National Park, southeastern Brazil. *Mammalia* 61(4): 547–560.
- Bonvicino, C.R., S.M. Lindbergh and L.S. Maroja. 2002. Small non-flying mammals from conserved and altered areas of Atlantic Forest and Cerrado: comments on their potential use for monitoring environment. *Brazilian Journal of Biology* 62: 765–774. doi: [10.1590/S1519-69842002000500005](https://doi.org/10.1590/S1519-69842002000500005)
- Bonvicino, C.R., J.A. Oliveira and P.S. D'Andrea. 2008. *Guia dos roedores do Brasil, com chaves para gêneros baseadas em caracteres externos*. Rio de Janeiro: Centro Pan Americano de Febre Aftosa – OPAS/OMS. 120 pp.
- Bradley, R.D. and R.J. Baker. 2001. A test of the genetic species concept: cytochrome-b sequences and mammals. *Journal of Mammalogy* 82: 960–973. doi: [10.1644/1545-1542\(2001\)082<960:ATOTGS>2.0.CO;2](https://doi.org/10.1644/1545-1542(2001)082<960:ATOTGS>2.0.CO;2)
- Brasil. 2002. Decreto de criação do Parque Nacional das Sempre Vivas. Decreto Federal s/nº. Brasília, December 13, 2002. Accessed at: [http://www.planalto.gov.br/ccivil\\_03/DNN/2002/Dnn9778.htm](http://www.planalto.gov.br/ccivil_03/DNN/2002/Dnn9778.htm), 24 July 2015.
- Bruford, M.W., O. Hanotte, J.F.Y. Brookfield and T. Burke. 1992. Single-locus and DNA fingerprinting; pp. 225–269, in: A.R. Hoelzel (ed.). *Molecular genetic analyses of populations. A Practical Approach*. Oxford: IRL Press. doi: [10.1016/0168-9525\(92\)90258-6](https://doi.org/10.1016/0168-9525(92)90258-6)
- Catzfis, F., J.L. Patton, A.R. Percequillo, C.R. Bonvicino and M. Weksler. 2008. *Euryzygomatomys spinosus*. IUCN Red List of threatened species. Version 2014.2. Accessed at <http://www.iucnredlist.org>, 27 August 2014.
- Cherem, J.J., P.C. Simões-Lopes, S. Althoff, and M.E. Graipel. 2004. Lista de mamíferos do estado de Santa Catarina, sul do Brasil. *Mastozoologia Neotropical* 11(2): 151–184. <http://ref.scielo.org/f4vf79>
- Cherem, J.J., M.E. Graipel, M. Tortato, S. Althoff, F. Brüggemann, J. Matos, J.C. Voltolini, R. Freitas, R. Illenseer, F. Hoffmann, I.R. Ghizoni-Jr, A. Bevilacqua, R. Reinicke, C.H. Salvador, A. Filippini, N. Furnari, K. Abati, M. Moraes, T. Moreira, L.G.R. Oliveira-Santos, V. Kuhnen, T. Maccarini, F. Goulart, H. Mozerle, F. Fantacini, D. Dias, R. Penedo-Ferreira, B.P. Vieira and P.C. Simões-Lopes. 2011. Mastofauna terrestre do Parque Estadual da Serra do Tabuleiro, estado de Santa Catarina, sul do Brasil. *Biotemas* 34(3): 73–84. doi: [10.5007/2175-7925.2011v24n3p73](https://doi.org/10.5007/2175-7925.2011v24n3p73)
- Chu, Y. K., R.D. Owen, L.M. Gonzalez and C.B. Jonsson. 2003. The complex ecology of hantavirus in Paraguay. *American Journal of Tropical Medicine and Hygiene* 69(3): 263–268. <http://www.ajtmh.org/content/69/3/263.abstract>
- Cirignoli, S., C.A. Garialli, U.F.J. Pardiñas, D.H. Podestá and R. Abramson. 2011. Mamíferos de la Reserva Vale Del Cunã, Pirú, Missiones, Argentina. *Mastozoologia Neotropical* 18(1): 25–43. <http://ref.scielo.org/h46zsk>
- D'Andrea, P.S., R. Gentile, L.S. Maroja, F.A. Fernandes, R. Coura and R. Cerqueira. 2007. Small mammals populations of an agroecosystem in the Atlantic Forest domain, southeastern Brazil. *Brazilian Journal of Biology* 67(1): 179–186. doi: [10.1590/S1519-69842007000100025](https://doi.org/10.1590/S1519-69842007000100025)
- Eisenberg, J.F and K.H. Redford. 1999. *Mammals of the Neotropics: the central Neotropics*. Chicago: University of Chicago Press. 460 pp.
- Embrapa Cerrados. 2006. Pirapora: Folha SE-23-X-C: cobertura vegetal dos biomas brasileiros. Brasília: Ministério do Meio Ambiente. Accessed at <http://mapas.mma.gov.br/mapas/aplic/probio/datadownload.htm?/cerrado>, 25 July 2015.
- Emmons, L.H and F. Feer. 1997. *Neotropical rainforest mammals: a field guide*. Chicago: University of Chicago Press. 307 pp.
- Fabre, P.H., T. Galewski, M. Tilak and E.J.P. Douzery. 2013. Diversification of South American spiny rats (Echimyidae): a multigene phylogenetic approach. *Zoologica Scripta* 42(2): 117–134. doi: [10.1111/j.1463-6409.2012.00572.x](https://doi.org/10.1111/j.1463-6409.2012.00572.x)
- Geise, L., L.G. Pereira, D.E.P. Bossi and H.G. Bergallo. 2004. Pattern of elevational distribution and richness of non volant mammals in Itatiaia National Park and its surroundings, in southeastern Brazil. *Brazilian Journal of Biology* 64(3B): 599–612. doi: [10.1590/S1519-69842004000400007](https://doi.org/10.1590/S1519-69842004000400007)
- Gonçalves, G.L., M.A. Faria-Correia, A.S. Cunha and T.R.O. Freitas. 2007. Bark consumption by the spiny rat *Euryzygomatomys spinosus* (G. Fischer) (Echimyidae) on a *Pinus taeda* Linnaeus (Pinaceae) plantation in South Brazil. *Revista Brasileira de Zoologia* 24(1): 260–263. doi: [10.1590/S0101-81752007000100037](https://doi.org/10.1590/S0101-81752007000100037)
- IBGE (Instituto Brasileiro de Geografia e Estatística). 2004. Mapa de Biomas do Brasil, primeira aproximação. Rio de Janeiro: IBGE. Accessed at <http://mapas.ibge.gov.br/interativos/arquivos/downloads>, 25 July 2015.
- Lacher, T.E. and C.J.R. Alho. 2001. Terrestrial small mammal richness and habitat associations in an Amazon Forest–Cerrado contact zone. *Biotropica* 33: 171–181 doi: [10.1111/j.1744-7429.2001.tb00166.x](https://doi.org/10.1111/j.1744-7429.2001.tb00166.x)
- Leal, K.P.G., I.R. Batista, F.L. Santiago, C.G. Costa and E.M.V.C. Câmara. 2008. Mamíferos registrados em três Unidades de Conservação na Serra do Espinhaço: Parque Nacional da Serra do Cipó, Parque Nacional das Sempre Vivas e Parque Estadual Serra do Rola Moça. *Sinapse Ambiental* (Edição Especial) 1: 40–50.
- Leite, Y.L.R., A.U. Christoff and V. Fagundes. 2008. A new species of Atlantic Forest Tree Rat, genus *Phyllomys* (Rodentia, Echimyidae) from southern Brazil. *Journal of Mammalogy* 89(4): 845–851. doi: [10.1644/07-MAMM-A-343.1](https://doi.org/10.1644/07-MAMM-A-343.1)
- Leite, Y.L.R and J.L. Patton. 2002. Evolution of South American spiny rats (Rodentia, Echimyidae): the star-phylogeny hypothesis revisited. *Molecular Phylogenetics and Evolution* 25(3): 455–464. doi: [10.1016/S1055-7903\(02\)00279-8](https://doi.org/10.1016/S1055-7903(02)00279-8)
- Lessa, G., P.R. Gonçalves, M.M. Morais-Júnior, F.M. Costa, R.F.

- Pereira and A.P. Paglia. 1999. Caracterização e monitoramento da fauna de pequenos mamíferos terrestres de um fragmento de mata secundária em Viçosa, Minas Gerais. Bios 7(7): 41–49.
- Mares, M.A. and R.A. Ojeda. 1982. Patterns of diversity and adaptation in South American hystricognath rodents; pp. 393–432, in: M.A. Mares and H.H. Genoways (eds.). Mammalian biology in South America, Pittsburgh: University of Pittsburgh.
- Modesto, T.C., F.S. Pessôa, M.C. Enrici, N. Attias, T. Jordão-Nogueira, L.M. Costa, H.G. Albuquerque and H.G. Bergallo. 2008. Mamíferos do Parque Estadual do Desengano, Rio de Janeiro, Brasil. Biota Neotropica 8: 153–159. doi: [10.1590/S1676-06032008000400015](https://doi.org/10.1590/S1676-06032008000400015)
- Moojen, J. 1952. Os roedores do Brasil. Rio de Janeiro: Instituto Nacional do Livro. 214 pp.
- Olson, D.M., E. Dinerstein, E.D. Wikramanayake, N.D. Burgess, G.V.N. Powell, E.C. Underwood, J.A. D'Amico, I. Itoua, H.E. Strand, J.C. Morrison, C.J. Loucks, T.F. Allnutt, T.H. Ricketts, Y. Kura, J.F. Lamoreux, W.W. Wettegel, P. Hedao and K.R. Kassem. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. Bioscience 51(11): 933–938 doi: [10.1641/0006-3568\(2001\)051\[0933:TEOTWA\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2)
- Paglia, A.P., G.A.B. Fonseca, A.B. Rylands, G. Herrmann, L.M.S. Aguiar, A.G. Chiarello, Y.L.R. Leite, L.P. Costa, S. Siciliano, M.C.M. Kierulff, S.L. Mendes, V.C. Tavares, R.A. Mittermeier and J.L. Patton. 2012. Lista anotada dos mamíferos do Brasil. 2 ed. Occasional Papers in Conservation Biology 6: 76 pp.
- Pinto, I.S., A.C.C. Loss, A. Falqueto and Y.L.R. Leite. 2009. Pequenos mamíferos não voadores em fragmentos de Mata Atlântica em áreas agrícolas em Viana, Espírito Santo, Brasil. Biota Neotropica 9(3): 355–360. doi: [10.1590/S1676-06032009000300030](https://doi.org/10.1590/S1676-06032009000300030)
- Sano, E.E., R. Rosa, J.L.S. Brito and L.G. Ferreira. 2007. Mapeamento de cobertura vegetal do bioma Cerrado: estratégias e resultados. Documentos 190. Planaltina: Embrapa Cerrados. 33 pp.
- Santos-Filho, M., F. Frieiro-Costa, I. Ára and M.N.F. Silva. 2012. Use of habitats by non-volant small mammals in Cerrado in Central Brazil. Brazilian Journal of Biology 72(4): 893–902. doi: [10.1590/S1519-69842012000500016](https://doi.org/10.1590/S1519-69842012000500016)
- Scheibler, D.R and A.U. Christoff. 2007. Habitat associations of small mammals in southern Brazil and use of regurgitated pellets of birds of prey for inventorying a local fauna. Brazilian Journal of Biology 67(4): 619–625. doi: [10.1590/S1519-69842007000400005](https://doi.org/10.1590/S1519-69842007000400005)
- Smith, M.F. and J.L. Patton. 1993. The diversification of South American murid rodents: evidence from mitochondrial DNA sequence data for the akodontine tribe. Biological Journal of the Linnean Society 50: 149–177 doi: [10.1111/j.1095-8312.1993.tb00924.x](https://doi.org/10.1111/j.1095-8312.1993.tb00924.x)
- Stallings, J.R., 1989. Small mammal inventories in an eastern Brazilian park. Bulletin of the Florida State Museum, Biological Sciences 34: 153–200.
- Verzi, D.H., M.G. Vucetich and C.I. Montalvo. 1995. Un nuevo Eumysopinae (Rodentia, Echimyidae) del Mioceno tardío de la Provincia de La Pampa y consideraciones sobre la historia de la subfamilia Ameghinianae 32(2): 191–195.
- Vilela, R.V., T. Machado, K. Ventura, V. Fagundes, M.J.J. Silva and Y. Yonenaga-Yassuda. 2009. The taxonomic status of the endangered thin-spined porcupine, *Chaetomys subspinosus* (Olfers, 1818), based on molecular and karyologic data. BMC Evolutionary Biology 9(29): 1–17. doi: [10.1186/1471-2148-9-29](https://doi.org/10.1186/1471-2148-9-29)
- Yonenaga, Y. 1975. Karyotypes and chromosome polymorphisms in Brazilian rodents. Caryologia 28: 269–286. doi: [10.1080/00087114.1975.10796617](https://doi.org/10.1080/00087114.1975.10796617)

**Authors' contribution statement:** ACL and YLRL conducted the analysis and wrote the text; MACP collected the specimens and prepared the vouchers and figures; VCJ collected the museum data; LGL conceived the research, organized the manuscript and wrote the text.

**Received:** 19 November 2014

**Accepted:** 18 August 2015

**Academic editor:** Ana Paula Carmignotto